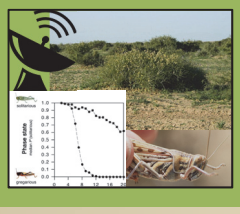

Mapping the spatio-temporal distribution of solitarious and gregarious desert locusts, *Schistocerca gregaria*, using remotely-sensed vegetation indexes

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Context

Spreading from Mauritania to India, over an area of more than 31 millions km², the desert locust, *Schistocerca gregaria*, is one of the major threat to cultivated lands in the world. Devastating bands and swarms are related to the gregarious individuals phase of the desert locust.

To **prevent desert locusts invasions** over such a wide-scale area and thereby to guarantee sustainable access to food to local farmers in developing countries, quantitatively reliable and accessible information on the spatial distribution of gregarious desert locusts are required.

Aim

This study aimed at modeling & mapping the presence of solitarious and gregarious desert locusts on the basis of remotely-sensed (RS) derived vegetation indexes.

Method

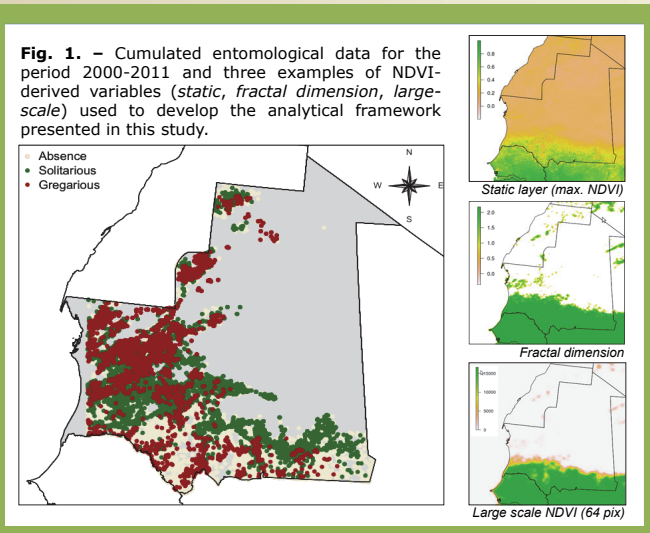

Fig. 1. – Cumulated entomological data for the period 2000-2011 and three examples of NDVI-derived variables (*static*, *fractal dimension*, *large-scale*) used to develop the analytical framework presented in this study.

A. Data

(1) Absent, solitarious & gregarious desert locusts observations for Mauritania from 1965 to 2012, extracted from the **RAMSES** database;

(2) Images of the Normalized Difference Vegetation Index (**NDVI**) (16-days, 250 m x 250 m resolution product) gathered from U.S. Geological Survey website, from 2000 to 2012; NDVI-derived variables:

- *Static*= Min./Max. NDVI found throughout 2000-2012;
- *Fractal dimension*;
- *Large-scale*= Nb. pixels with NDVI > 0.14, for distance [32-64 pix];
- *Small-scale*= Local NDVI or Mean focal NDVI for distance [3-5 pix];
- *Temporal*= NDVI rate of change within 16, 32 & 48-days period.

B. Model

A multinomial log-linear model was implemented to predict the probability to observe absence (i), presence of solitarious (ii) or presence of gregarious (iii) desert locusts categories, and this according to NDVI-derived variables (**Fig. 1**).

C. Output predictive maps

The model was applied to the predictor images for a given period, so that the predicted probabilities can be made in each 250 m pixel covering Mauritania.

Results

- **36 412 records** were used to evaluate the influence of NDVI-derived variables on *S. gregaria* spatial distribution;
- The predicted distributions of absence/presence of solitarious & gregarious desert locusts are presented on **Fig. 2**;

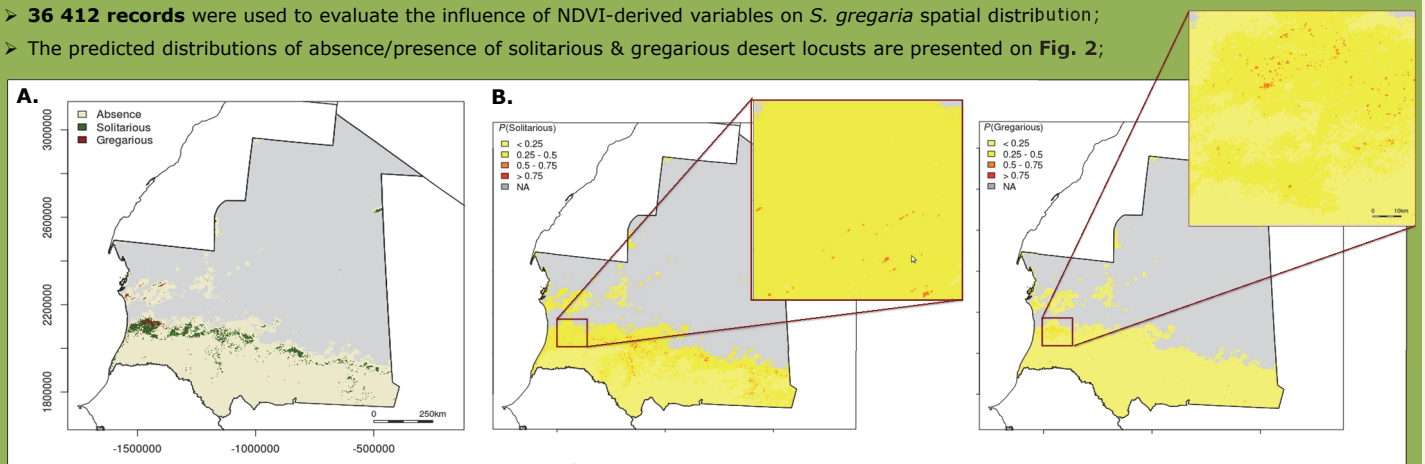

Fig. 2. – Predicted distribution of *Schistocerca gregaria* on July, 27th, 2012: **A.** Absence, presence of solitarious or gregarious desert locusts (beige, green and red dots respectively) according to a threshold probability >= 0.5; **B.** Probability ranges for solitarious (left) and gregarious phases (right).

- Currently, the modeling framework has **low to medium accuracy** (Kappa= 0.28);
- Multinomial log-linear model **lowered type II errors** (false negatives) by up to 50%, in comparison to the 0/1 logistic model.

Perspectives

1/ Incorporating second generation NDVI products (e.g. MC10 NDVI) to fill missing data on the center/north-west Mauritania (grey areas);

2/ Quantifying the effect of temperature & accounting for spatial autocorrelation to increase accuracy & confidence on model predictions;

3/ Producing enhanced maps with cumulative probabilities for selected periods (e.g. seasons) – together with uncertainty maps – to help decision makers for timely interventions to prevent desert locust invasions.

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